REMARKS

The Office Action of October 8, 2003 has been received and its contents carefully considered.

Claims 3-13 are all the claims pending in the application.

Claims 4 and 5 have been rejected under the second paragraph of 35 U.S.C. § 112 as indefinite.

The Examiner points out that claims 4 and 5, which are dependent claims, do not recite the claim from which they depend. The Examiner states that he assumes that both claims 4 and 5 are meant to depend from claim 3.

The Examiner is correct that claims 4 and 5 were meant to depend from claim 3. Due to an inadvertent typographical error, the claim number from which claims 4 and 5 depend was omitted. Applicants have amended claims 4 and 5 to correct this error.

Claims 3 to 8 and 13 have been rejected under 35 U.S.C. § 103(a) as obvious over Dickson et al.

Applicants submit that Dickson et al do not disclose or render obvious the presently claimed invention and, accordingly, request withdrawal of this rejection.

As set forth in claim 3, the present invention is directed to a carbon fiber woven fabric that is obtained by firing in a non-oxidizing atmosphere a cellulose-based woven fabric in a temperature range of 900 to 3000°C, and which has a thickness in the range of 0.05-0.4 mm, a volume resistivity of less than 0.2Ω•cm in the layer direction, and a gas permeability of not less

than 1500/cc/cm^2/hr/mmAq, and wherein the electrical resistance in the direction of thickness of the woven fabric is no greater than 50 mΩ•cm^2 as measured between two copper plates with a load of 4 kgf/cm^2.

Thus, applicants have amended claim 3 to recite the non-oxidizing atmosphere and the temperature range of the firing.

The carbon fiber woven fabric of the present invention has a sufficient mechanical strength and an excellent conductivity in the direction of the thickness (layer transverse direction) of the woven fabric, which is useful, for example and particularly, as an electrode for a fuel cell. A carbon fiber woven fabric having an electrical resistance in the direction of the thickness of the carbon fiber woven fabric as in the present invention has not been known in the prior art.

The Examiner states that Example 2 of Dickson et al discloses a carbon fiber cloth having a thickness of about 0.025 inches, which equals 0.635 mm. The Examiner acknowledges that this value falls outside of the range of the present claims where the thickness of the fired carbon fiber woven fabric is recited to be 0.05 to 0.4 mm.

The Examiner argues that a decrease in the thickness of the fabric would result in an adjusting of a result effective variable, with the result being a decreased resistivity. The Examiner argues that it would have been obvious to make the thickness of the carbon fabric smaller than 25 mils in order to decrease its resitivity, since legal decisions indicate that discovering an optimum value of a result effective variable involves only routine skill in the art.

Applicants point out, however, that the Examiner is not correct that a decrease in the thickness of the fabric would result in a decreased resistivity.

Reduction of the thickness of a fabric does not result in a decrease in the electrical resistance (in the direction of the fabric layer) as long as the material is the same. The electrical resistance in the direction of the fabric layer is the inherent electrical resistance of the material.

The present invention has attained a reduced electrical resistance in the direction of the thickness of the carbon fiber woven fabric of 50 $m\Omega \cdot cm^2$ or less under a load of $4kgf/cm^2$. This advantageous characteristic of the present invention is not attained or suggested in Dickson et al.

In Paragraph 8 of the Office Action, the Examiner acknowledges that applicants have argued that the Examiner is not correct in asserting that a decrease in the thickness of the fabric would result in a decreased resistivity. The Examiner states, however, that resistivity is a measure of electrical resistance per unit length. The Examiner argues that if the thickness is decreased, the length the electricity must travel is lower and, thus, the resistivity would be decreased. The Examiner states that he maintains his assertion that a decrease in thickness would result in a decrease of resistivity.

In response, applicants submit that the Examiner is not correct that a decrease in thickness would result in a decrease in resistivity. The Examiner bases his argument on the assertion that a decrease in thickness will result in a lower length of travel for the electricity. However, applicants point out that there is no scientific reason why the electricity would travel for a lowered length as a result of a decrease in thickness. Further, applicants point out that there is no suggestion in Dickson et al to lower the length or the resistivity.

Applicants submit that the Examiner has made a scientific error in his statement that a decrease in the thickness of the fabric would result in a decreased resistivity.

The Examiner states that with respect to the other property recitations of the claims, that although Dickson et al do not specifically disclose the recitations for gas permeability, compressive strength, electrical resistance measured between two copper plates, and orientation, he takes the position that it is reasonable to presume that these recitations are inherent in the Dickson et al invention.

The Examiner argues that his presumption of inherency is reasonable because similar materials are employed, that is, cellulose-based woven fabrics, in a similar production process, that is, firing in a non-oxidizing atmosphere to create a carbon fabric to produce a conductive carbon fabric. The Examiner states that the burden is upon applicants to show that the Dickson et al process would not inherently result in the recitations of the present claims.

Applicants submit that the Examiner is not correct that the process described in Dickson et al would inherently result in the recitations of the present claims. Inherency exists only when the process disclosed in the prior art necessarily and always produces the same result. In the present case, the Examiner is merely guessing that the same result may be obtained because "similar" materials and processes allegedly were employed. This is insufficient to support an allegation of inherency.

Further, Dickson et al do not note the relationship between the orientation of a cellulose fabric and the layer transverse direction electrical resistance. In preferred embodiments of the

present invention, a high orientation is used to obtain a low layer transverse direction electrical resistance of the carbon fiber fabric.

The present inventor found that use of a certain cellulose fabric in a certain manner and fired to obtain a carbon fiber fabric can produce a carbon fiber fabric having desirable properties, which was not known.

Further, the production process of a carbon fiber fabric is not the same between Dickson et al and the process that was employed to obtain the carbon fiber woven fabric of the present invention. In Dickson et al, a black insulating fiber material is first obtained by a thermochemical conversion of regenerated-cellulose fiber starting material by impregnating clean starting material with a metal phosphate salt, and heating the salt-impregnated fiber material for a short time of 5 to 30 minutes in air to produce a flexible black insulative fiber material, and then carbonizing this black material by rapidly heating for 5 to 30 minutes in a non-oxidizing atmosphere to form an electrical conductive fiber material. In a typical process that was employed to obtain the carbon fiber woven fabric of the present invention, a cellulose material was heated in non-oxidizing atmosphere at 900°C (Examples 1-4) for 1 week to obtain a carbonized material, which is then further fired at 1800°C, if necessary, to obtain a carbon fiber fabric. Thus, Dickson et al used a thermochemical conversion in an oxygen atmosphere and a subsequent rapid carbonization, whereas a typical process employed to produce the carbon fiber woven fabric of the present invention employed an extended firing in a non-oxidizing atmosphere, to form a carbon fiber fabric. Thus, the process is different between Dickson et al

and a typical process that was employed to produce the carbon fiber woven fabric of the present invention.

Thus, the present invention does not reside in recitations of properties which can be obtained only by adjustment of the Dickson et al process.

At page 4, line 8 to page 5, line 4 of the Office Action, Examiner sets forth additional comments concerning his inherency argument. The Examiner states that it is reasonable to presume that Dickson et al inherently produce the present invention because (1) Dickson et al use a commercial cellulose-based fabric based on a plain weave, which is the same starting material as in the present invention, and (2) Dickson et al employ processes that are similar to those employed in the present invention. The Examiner refers to specific portions of Dickson et al by column and line number, and compares these disclosures to specific portions of the present specification.

As discussed above, applicants submit that the processes of Dickson et al and those used to produce the carbon fiber woven fabric of the present invention are different with respect to the fact that Dickson et al employ an oxidizing gas and a rapid carbonization, whereas the process to produce the carbon fiber woven fabric of the present invention employs a non-oxidizing atmosphere over a long period of time. The Examiner points out a number of similarities in various steps of the processes and, therefore, concludes that these processes are similar and would result in the same product.

Applicants submit that this position of the Examiner is an oversimplification of the processes that are employed in Dickson et al, and ignores the specific teachings of Dickson et al

that the rapid carbonization and use of an air atmosphere in Dickson et al result in fabrics that are substantially different from those that employ a non-air atmosphere over a long period of time.

In particular, Dickson et al state, at column 9, line 67 to column 10, line 5, that the products of the Dickson et al invention

> "...owing to the rapidity of the process, are significantly different than those reported by other workers which are made by lengthy heating of cellulose fiber material up to high temperatures reached at a slow rate or by gradual increments, requiring carefully controlled heating over a period of several hours or more.... They are also different from the partially carbonized fibers which have been made by fairly rapid pyrolysis of cotton and other cellulosic fibers by successive heat treatments at temperatures ranging from about 300°F. to above 1500°F., requiring the substantial absence of oxygen during all of the heat treatments."

Dickson et al further disclose at column 5, lines 50 to 54 that "heating in the presence of air... appears to be essential to the production of the presently desired product fibers".

Accordingly, the specific teachings in Dickson et al recognize that the products they produce will be significantly different from those that are obtained by a long heat treatment in a non-oxidizing atmosphere. Therefore, applicants submit that it is not reasonable for the Examiner to assume that the Dickson et al process will inherently produce the carbon fiber woven fabric of the present invention.

The Examiner further states that, in the alternative, the claimed properties would obviously have been provided by the process disclosed by Dickson et al by way of adjusting result effective variables to improve the conductivity of the fabric.

Applicants disagree with this statement because Dickson et al do not contain any teaching or suggestion to adjust variables to obtain the electrical resistance of the present claims.

Applicants point out that the product of the present invention has excellent conductivity in the thickness direction. The present invention is characterized in that the electric resistance in the layer transverse direction is 50 $m\Omega/cm^2$ under a load of 4kgf/cm2, which is lower than the conventional ones.

In the present invention, the fibers of a carbon fiber woven fabric are highly oriented in the layer transverse direction, in comparison with the prior art carbon fiber fabric, by which the electric resistance in the layer transverse direction is far lower than that of the prior art carbon fiber fabric. See, for example, page 6, lines 21-31 of the present specification.

Further, applicants submit that it would not have been obvious to adjust the various result effective variables of Dickson et al to arrive at the properties set forth in the present claims. Dickson et al do not provide any guidance or motivation to adjust variables to arrive at the properties of gas permeability and orientation recited in the present claims. Thus, Dickson et al do not even mention gas permeability and orientation as properties that are of any importance. Therefore, one of ordinary skill would not be motivated to find the optimum values for these properties.

The Examiner states that with respect to claim 7, Dickson et al disclose, at column 14, lines 36-39, that the properties can be modified by inclusion of fluoro-carbon fibers.

Dickson et al describe inclusion of fibers of other types such as fluoro-carbon fibers in varnish or resin impregnant to modify ablative and other properties.

However, even if a fabric containing fluoro-carbon fibers is fired, a carbon fiber fabric having a water repellant property of claim 7 of the present application cannot be obtained.

In order to obtain a carbon fiber fabric having a water repellent property of claim 7, it is necessary to coat a water repellant resin onto a carbon fiber fabric. Dickson et al do not teach such a coating.

Further, the amount of the water repellant resin preferably should be not more than 60% by mass, so as not to deteriorate the electrical resistance and gas permeability. Dickson et al do not teach coating of a water repellant resin, or anything about electrical resistance and gas permeability.

In Paragraph 14 of the Office Action, the Examiner argues that with respect to claim 7, applicants do not recite a coating, but only recite that the carbon fiber woven fabric has a water repellency. The Examiner argues that since fluorocarbon acts as water repellant, it would supply a water repellant property to the fabric, to some degree. The Examiner argues that Dickson et al do not need to teach coating the fabric, because applicants do not claim coating the fabric.

In response, applicants have amended claim 7 to recite that a water repellant resin is coated in an amount of 5 to 60% by weight based on the carbon fiber fabric. See the present specification at page 13, lines 4 to 9 for support for this amendment. Further, applicants direct the Examiner's attention to Table 2 of the present application where Examples 1 to 4 show results for carbon fiber woven fabrics according to claim 7 that contain a coating of a water

repellant resin and Examples 11 to 14 show results for the same carbon fiber woven fabrics, but without the coating of a water repellant resin. As can be seen from Table 2, the carbon fiber of Examples 1 to 4 prevented water absorption and had enhanced water repellency as compared to Examples 11 to 14.

Accordingly, applicants submit that claim 7 provides a further basis for patentability over Dickson et al.

Further, Dickson et al do not disclose or suggest the orientation recited in claims 4 or 5. Accordingly, applicants submit that these claims provide an additional basis for patentability over Dickson et al.

With respect to claims 4 and 5, the Examiner acknowledges that Dickson et al do not discuss orientation, but takes the position that since applicants state in the specification, at page 10, lines 7 to 26, that the claimed orientation is achieved with a plain woven cellulose-based fabric and since Dickson et al also disclose using a commercial plain weave cellulose-based fabric, it is reasonable to assume that the claimed orientation would be present in Dickson et al, since Dickson et al do not teach a modification in the orientation of the fabric.

In response, applicants point out that the specification at page 10, lines 7 to 26, does not state that a plain weave achieves the orientation of claims 4 and 5. The orientation of claims 4 and 5 is a special orientation that is higher than the orientation of a normal plain weave, and is achieved, for example, by inserting orienting components in the plain weave. In the present invention, a high layer transverse direction orientation carbon fiber fabric is intentionally obtained. Applicants note that they have amended claims 4 and 5 to add the definition of

orientation as being q/(p+q), as disclosed at page 9 of the specification, and have amended claim 5 to make it clearer.

Moreover, claim 4 specifically states that there is an orientation component having an orientation (q/((p+q)) of 4/9 or greater. Dickson et al do not show such an orientation component.

In Paragraph 10 of the Office Action, the Examiner acknowledges applicants' argument that Dickson et al do not note the relationship between the orientation of the cellulose fabric and the layer transverse direction of electrical resistance.

The Examiner asserts that applicants state in the specification that the orientation of a conventional plain weave cellulose-based fabric satisfies the orientation requirement of the present claims and that Dickson et al also use a commercial plain weave cellulose-based fabric and, therefore, would be expected to obtain the same orientation.

Applicants point out, as discussed above, that the orientation recited in claims 4 and 5 is not the orientation of a plain weave carbon fiber, but is an orientation that is greater than the normal orientation achieved with a plain weave carbon fiber. The orientation in claim 4 is achieved by inserting orienting components in the plain weave. In the present invention, a high layer transverse direction orientation carbon fiber fabric is intentionally obtained.

In Paragraph 9 of the Office Action, the Examiner repeats his position that although the processes used to create both fabrics are not exactly the same, they are similar enough to support

a conclusion that the product of Dickson et al would have the same properties as in the present invention.

Again, applicants submit that the Examiner has ignored the specific teachings of Dickson et al which indicate that the properties would be different based on the differences in the processes. See applicants' discussion above.

The Examiner further states that applicants have failed to point out how the material of Dickson et al is different from the present invention so that it would not possess the claimed properties. In response, as discussed above, Dickson et al themselves recognize that the differences in process conditions will result in different properties.

In Paragraph 11 of the Office Action, the Examiner acknowledges that applicants have argued that the use of a certain cellulose in a certain manner and fired to obtain a carbon fiber fabric can produce a carbon fiber fabric having desirable properties.

The Examiner asserts, however, that the certain cellulose fabric and the certain manner that are used to obtain these desirable products, as shown in the specification, do not materially differ from that which is disclosed by Dickson et al.

As discussed above, applicants submit that the processes used in Dickson et al and the present invention are different, and that Dickson et al specifically acknowledge that differences in the process will result in different products.

Moreover, as discussed above, a woven fabric having a specifically high layer transverse direction orientation should be specifically fabricated or selected and used to produce a carbon fiber fabric of the present invention, which is not usual.

In Paragraph 12 of the Office Action, the Examiner again argues that while there may be some small differences in the production processes, they are essentially similar and do not appear to be materially different because both processes produce a fully carbonized fabric after heating in a non-oxidative atmosphere.

The Examiner also points out that the steps of production are not present in the current claims which are directed to the product itself.

In response, applicants have amended claim 3 to recite the non-oxidizing atmosphere and temperature range for the firing. Further the process steps which enable different products to be produced, as is recognized by the teachings in Dickson et al teaching that different process conditions will result in different products, and the present claims recite the product characteristics.

The Examiner also points out that while Dickson does initially heat in an oxygen atmosphere, Dickson et al later heat in a non-oxygen atmosphere, similar to applicant. This assertion by the Examiner, however, ignores the specific teachings in Dickson et al that the use of entirely non-oxidizing atmosphere results in products that are different from his products which employ an oxidizing atmosphere as part of the treatment.

In Paragraph 13 of the Office Action, the Examiner acknowledges that applicants have argued that Dickson et al do not provide any guidance or motivation to adjust variables to arrive at the properties of gas permeability and orientation recited in the present claims. The Examiner asserts, however, that applicants have failed to show in the specification any kind of process of producing that is materially different from that shown in Dickson et al.

Again, this position by the Examiner ignores the specific teachings in Dickson et al that recognizes the differences in atmosphere and treating time result in different products.

The Examiner asserts that adjusting known variables such as gas permeability and resistivity, in the art of fuel cells, is common to achieve desired properties. Applicants point out that the Examiner does not provide any evidence to support this assertion, and does not provide any indication of how one would adjust these variables.

In view of the above, applicants submit that Dickson et al do not disclose or render obvious the subject matter of the present claims and, accordingly, request withdrawal of this rejection.

In view of the above, reconsideration and allowance of this application are now believed to be in order, and such actions are hereby solicited. If any points remain in issue which the Examiner feels may be best resolved through a personal or telephone interview, the Examiner is kindly requested to contact the undersigned at the telephone number listed below.

The USPTO is directed and authorized to charge all required fees, except for the Issue Fee and the Publication Fee, to Deposit Account No. 19-4880. Please also credit any overpayments to said Deposit Account.

Respectfully submitted,

Sheldon I. Landsman

Sheldon I. Landsman
Registration No. 25,430

SUGHRUE MION, PLLC
Telephone: (202) 293-7060
Facsimile: (202) 293-7860

WASHINGTON OFFICE
23373
CUSTOMER NUMBER

Date: April 8, 2004